Dark Energy-Dark Matter or Modified gravity ?

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Cosmic Acceleration

1. Cosmological constant

2. Dark energy models: Scalar field or parameterized equation of state

3. Modified gravity

Dynamically (2) and (3) are equivalent (arxiv:0704.0680)

Anomalies in dynamics

1. Dark energy $\ddot{d}_H = \frac{\ddot{a}}{a} d_H \approx cH_0 \approx 10^{-10} m/s^2$

2. Dark Matter $a_{MOND} \approx -10^{-10} m/s^2$

3. Pioneer anomaly $a_p \approx -8 \times 10^{-10} m/s^2$

Possible approaches:

1. Studying the dynamics of systems, using modified filed equation of

   $$f(R, R_{\mu\nu}R^{\mu\nu}, R_{\mu\nu\lambda\alpha}R^{\mu\nu\lambda\alpha})$$

2. Conformal transforming and working in Jordan frame. $S = \int \tilde{R}\sqrt{-g}\,dx^4 + \kappa \int L(\varphi, \varphi_{,\mu}\varphi^{,\mu})$

3. Modifying the geodesic equation (Palatini formalism): Extra terms may mimic to dark energy and dark matter

Modified GR goals

- Provide a late time acceleration
- It can make an inflationary epoch.
- Can it produce an Harrison-Zeldovich power spectrum from the inflationary epoch ?
- Replacing dark matter with modified GR (effective MOND like potential) ?
- If so how can it play the role of dark matter in the structure formation process (comparing with the observed power spectrum) ?
- Pioneer anomaly ?